Zinc isotopes in polluted substrates

E. COUDER[1]*, B. DELVAUX[1], C. MAERSCHALK[2] AND N. MATTIELLI[2]

[1]Unité des sciences du sol, Université catholique de Louvain, Croix du Sud 2/10 1348 Louvain-la-Neuve Belgium (*correspondence: Eleonore.Couder@uclouvain.be)
[2]DSTE, Université Libre de Bruxelles 1050 Brussels Belgium

Plant-soil feedback processes are crucial in the biogeochemical cycle of trace elements. In particular, plants absorb zinc as an essential nutrient from soil solution. Excessive root uptake of zinc from contaminated substrates can lead to food web contamination.

This study focuses on zinc isotopes in the solid and liquid phases of a slag deposit (SD) from a metallurgical industry, and two aerosol-contaminated soils: a calcareous soil (CaS) and a shale-derived soil (ShS). Fine earth fractions (fef, <2mm) were obtained by dry sieving. Solutions were collected *in situ* under organic (O) and organo-mineral (Ah) horizons. After zinc purification by a novel chromatographic method performed on micro-columns (Zn blanks $\leq$ 2ng), the values of the Zn isotopic ratio (δ^{66}Zn) were measured on a Nu Plasma MC-ICP-MS.

Fef determinations show that SD was richer in heavy isotopes (0.37-0.43 ‰) than soils contaminated by aerosols (0.12 – 0.27 ‰), in agreement with the known effect of industrial Zn extraction process. Enrichment in heavy Zn isotopes was observed from CaS-O (0.12 ‰) to CaS-Ah (0.28 ‰), suggesting specific bounds of light Zn to organic matter. δ^{66}Zn in ShS-Ah (0.12‰) was lower than in CaS-Ah thus likely because of the higher C content of the former (48 vs 33 g kg^{-1}).

Relatively to fef, soil solutions were enriched in light Zn in CaS-O (-0.21 ‰) and CaS-Ah (no data yet on SD and ShS), leading to the respective fractionation magnitudes of 0.33 ‰ and 0.18 ‰. Ion exchange processes likely promoted the release of light Zn isotope in solution.

Our data suggest that Zn isotopic fractionation is highly promising to the study of zinc mobility in the soil-plant cycle.

The influence of phase separation on the flow patterns of mid-ocean ridge hydrothermal systems

D. COUMOU, T. DRIESNER AND C.A. HEINRICH

Institute of Isotope Geochemistry and Mineral Resources, ETH Zurich, Clausiusstrasse 25, 8092 Zürich, Switzerland (coumou@erdw.ethz.ch, thomas.driesner@erdw.ethz.ch, heinrich@erdw.ethz.ch)

We present the first fully transient simulations of fluid flow in mid-ocean ridge type hydrothermal systems that include the full complexity of the H_2O-NaCl phase diagram [1, 2]. Mass and energy transport are computed with a novel pressure-enthalpy-composition-based algorithm that replaces our earlier pressure-temperature-composition scheme [3].

A series of simulations has been done, exploring what we considered the most important part of the “geological” parameters space, i.e., we studied the influence of water depth, permeability, and heat flow. This was done in a 2D rectangular geometry with horizontal and vertical dimensions of 3500m and 1000m, respectively. At the bottom boundary, heat was supplied in form of a gaussian distribution, mimicing an underlying magma chamber.

All simulations show phase separation phenomena. Water depth is a major control on what regions of the phase diagram (single phase fluids, vapor+liquid, vapor+halite, liquid plus halite, vapor+liquid+halite) are encountered in the hydrothermal system. Typically, systems that discharge at 1500 m water depth show a systematic distribution of these phase regions in the subsurface, with the upflow zone consisting of a vapor+liquid mixture and zones of vapor+halite and liquid+halite above the magma chamber. With increasing water depth, regions of phase separation become smaller and the upflow zone may consist entirely of a single phase fluid.

Salinity at the site of discharge is mostly determined by the interplay of phase separation in the deep parts and admixture of seawater along the upflow path. Transient changes between vapor and brine dominance in the discharging fluids appear to be restricted to the shallower systems while deep systems tend to discharge stably at sub-seawater salinities until the heat source is switched off and the deep brine layer may be mobilized. The observed salinities and their stability/instability as a function of water depth are in excellent agreement with observations on natural examples.

[1] Driesner & Heinrich (2007) *GCA* **71**, 4880-4901. [2] Driesner (2007) *GCA* **71**, 4902-4919. [3] Geiger *et al.* (2006) *Transport in Porous Media* **63**, 399-434.